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USE OF ROENTGEN PHOTOGRAMMETRY IN PHTISIOLOGY

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ABSTRACT: The present work summarizes the results of the research and practical use of roentgen photogrammetry carried out by Moscow Scientific Research Institute for Tuberculosis of the Ministry of Health of RSFSR for studying the morphology and function of bronchi. A five-year clinical experience in tuberculosis has shown that a stereoscopic analysis of roentgenograms, supplemented with photogrammetric data, allows the physician to study more minutely the character of tuberculous process and diagnose it more safely.

With every year the shortcomings of traditional roentgenotopometric methods in medicine are felt more and more critically. The low precision of these methods cannot satisfy pulmonologists and phtisiologists when studying the morphology and function of lungs affected by tuberculous process. Only roentgen photogrammetry, which achieved its development in medicine during recent years, is able to describe in full measure the topography and dynamics of a tuberculous process.

The given work describes the experience of roentgen photogrammetry use in the clinic of Moscow Tuberculosis Research Institute of the Russian Federation Ministry of Health for the studying the morphology and function of bronchi and also for the topography of a tuberculous cavity.

In patients with tuberculosis and other chronic pulmonary diseases an uneven shift of vessels and bronchi takes place, and also their fixation, and sometimes - a marked deformation. These phenomena are attributable to the decrease of the volume of more or less significant pulmonary tissue parts.

The most significant changes in the topography of pulmonary segmental bronchi are observed in patients with fibrous-cavernous tuberculosis.

A precise topographoanatomic description of intrapulmonary situation is achieving a paramount importance for the assessment of therapeutic possibilities and for answering a question of therapy character and volume.

Roentgenography of bronchi with the use of radiopaque substances is widely used in clinical phthisiology for the assessment of bronchial tree anatomic and functional state.

A roentgenologic description of bronchi function comes upon definite difficulties conditioned by the intricacy of volumetrical broncho-pulmonary structure deciphering from the flat roentgenographic imprint. Even roentgenography in two interperpendicular projections in most cases does not allow to reproduct for certain the spatial going of bronchial branches.

Stereoroentgenogrammetry for a long time has not been used for the investigation of bronchi. This is explained by the fact that the widely spread method of roentgen stereopair receipt by the way of roentgen tube shift is not acceptable for the immovable organs survey because of the great time interval between the expositions of the left and right imprints. A special two-tubed stereoroentgenographic apparatus is not turned out by industry.

An automatic stereoroentgenographic plant has been created in the scientific-technical experimental department of Moscow Tuberculosis Research Institute. This plant allows to receive the imprints for the usual stereoscopic analysis and for the stereophotogrammetric treatment. The plant is made in the form of the mechanism additional to the serial clinical radiodiagnostic apparatus and has got a stereo support with two roentgen tubes, a stereo cassette, a high-voltage switch and an automatic system of survey regulation [1]. A stereo support is provided with mechanic assemblies permitting to level the camera with the aim of receiving the imprints answering the conditions of the normal survey case [2].

Chest stereoroentgenography in adults is done with the focal distance of 1000 mm and the basis of 200 mm. When studying respiratory function in patients with pulmonary diseases stereoroentgenography of contrasted bronchi is done twice: in the moments of maximal breath and expiration. A patient holds his breath for the moment of roentgenography. The survey speed of 2 sequences per second ensures the receiving of a qualitative stereopair, where the dynamic unsharpness and vertical parallaxes conditioned by the bronchi motion are practically absent.

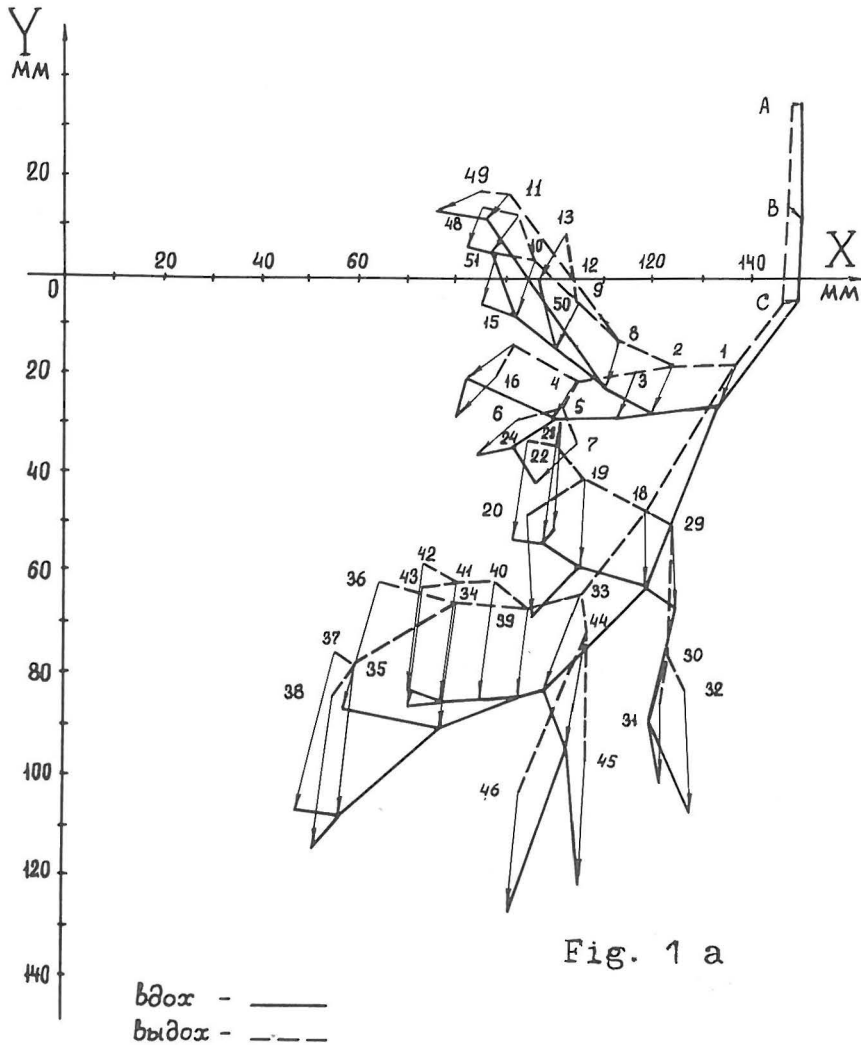
A stereoscopic model of contrasted bronchi reproduces well the spatial going of bronchial branches with different calibres. When using a contour contrasting one can see also

the relief of major bronchi and trachea inner wall.

A photogrammetric treatment of imprints is done analytically on the stereocomparator with the use of a calculator. Treating imprints this way, one obtains diameters, length, or bronchi boughing angles and their values changes in the course of breathing. Besides that, one can determine the spatial coordinates of bronchial tree points by breath and expiration according to which the graphic model of breathing is built.

Case report: the results of a stereoroentgenogrammetric survey of contrasted bronchi. A patient Z., age - 50 years, had been admitted to the diagnostic department of the institute in order to define more exactly the diagnosis of pathologic changes in the right lung upper lobe.

The achieved numerical data allowed to detect the changeability of bronchi lumen by opposite phases of breathing in the affected zone. This is especially so in places of bronchiectases formation, that can be explained by a marked thinning of bronchial walls, and, probably, also by their paralytic state.



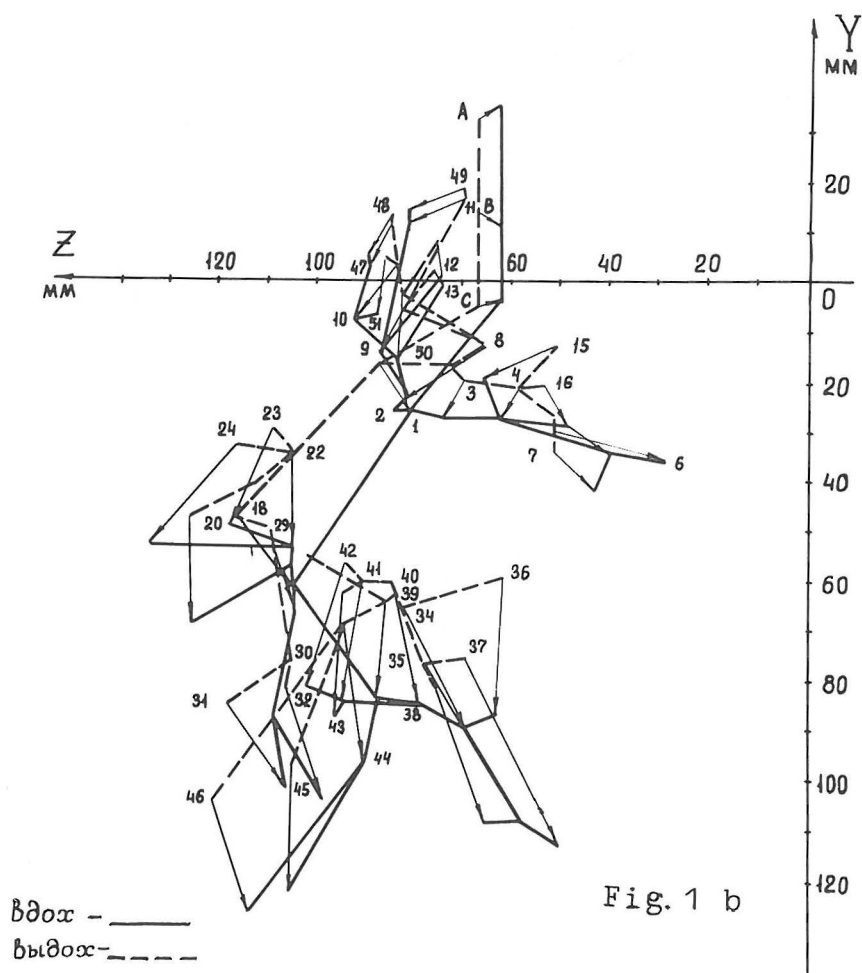


Fig. 1 b

In the zone of the greatest pathologic changes a noticeable decrease of bronchi length takes place compared to the normal values, that is in direct dependence upon the enormous increase of the mentioned bronchial trunks. The changes of bronchi boughing angles by different breathing phases in normal and pathologic state proceeds unequally. In the zone of pulmonary tissue pathology boughing angles of some bronchi increase by breath, but of some ones - decrease, while in control the bifurcation angles increasing takes place by breath.

A graphic model of the given patient's breathing speaks to the fact that the greatest change of bronchi shift amplitude in breathing takes place in the sagittal plane, i.e. - YZ / Fig. 1/.

A complex clinical-roentgenologic investigation, including stereobronchography with the subsequent photogrammetric treatment of imprints allowed to ascertain in full enough measures the state of bronchi and to speak of the volumetrical upper lobe decrease due to pneumosclerosis. After special preparation the patient was done a resection of the right lung upper lobe. A histologic investigation of the resected lobe confirmed the diagnosis: pulmonary tissue was sclerozed; a connecting infiltration of bronchial walls was observed;

bronchoectases took place.

In cavernous tuberculosis pathologic cavities of a round shape are formed in lungs / tuberculous cavities /. This type of tuberculosis is the most severe one, requiring a long-course in-patient treatment.

One of the most effective ways of cavernous tuberculosis therapy is the drug intracavernous blowing according to the method offered by I.M. Bondarev and L.I. Zhigalina [3]. Drug administration into the cavity is performed through the channel of a special surgical needle. The success of this procedure depends in large upon the preceding roentgentopographic preparation, during which the dimensions, localization and topography of the inner cavity wall are determined. The knowledge of the cavity wall relief is extremely important when fibrosed cavities are treated, the inner wall surface of which contains hollows, pockets, crosspieces and other elements.

For the determination of cavity dimensions and localization from the roentgen stereopair, diameter and coordinates of the cavity centre are measured in relation to the reference marks, fastened upon a patient's body surface.

The topography of the tuberculous cavity inner wall is not reproduced by the stereopair. Instead of the expected spherical surface the observer sees the flat ellipsis in the intercostal space. This is explained by the fact that the pulmonary tissue surrounding the cavity absorbs X-rays equally and produces a homogenous shadow on the imprint. Only a thin wall of the cavity, containing calcium, is reproduced in the form of a ring on the roentgenogram. In case, if the cavity is filled with the radiopaque substance, a flat disk is observed in space of a stereomodel.

Nothing considerably new is added also by the tomography of a contrasted cavity, for the accumulation of a radiopaque substance on its bottom is not detalized when being investigated as such.

A new method of cavernography has been developed in Moscow Tuberculosis Research Institute of Russian Federation Ministry of Health, allowing to reproduce the cavity inner wall topography [4].

The realization of this procedure forsees the stereo-roentgenography of a tuberculosis cavity 1 on different stages of contrasting with the help of an automatic stereoroentgenographic apparatus 2 / Fig. 2 a /.

The stereopairs recieved / 3,4; 5,6; 7,8; 9,10 / are measured in a stereocomparator, and the depth of the radiopaque substance upper level bedding for each stereopair is recieved. The the borders of the radiopaque substance level are transferred form every subsequent stereopair to the first one 3,4, having been done without contrasting.

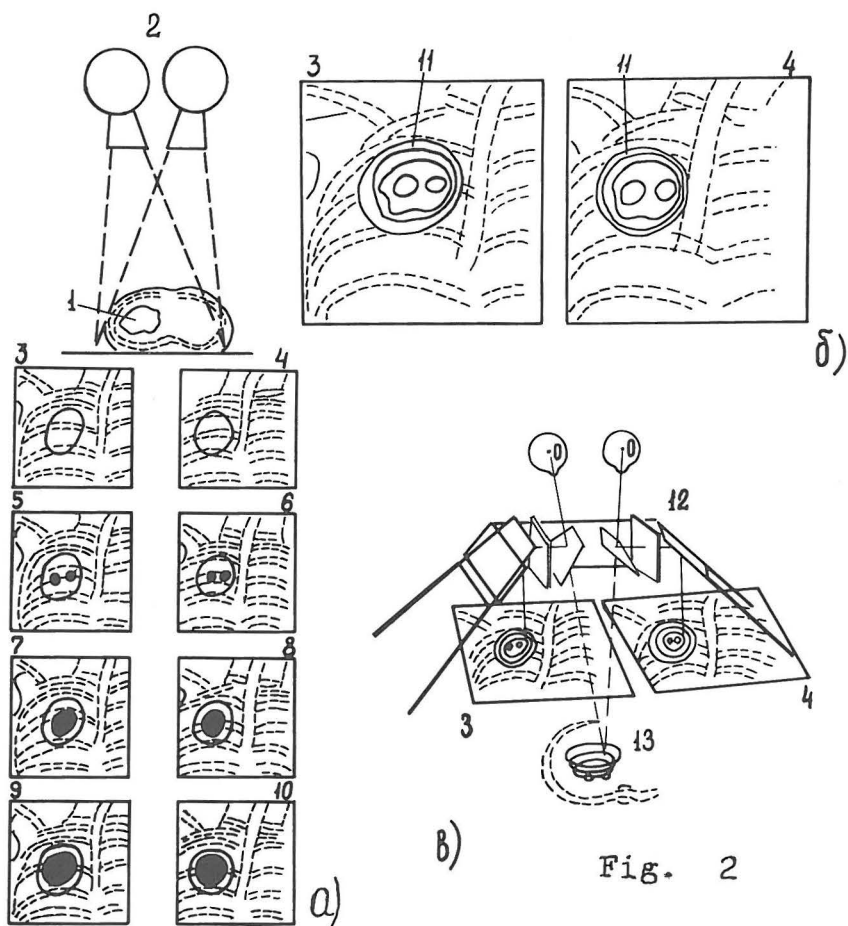


Fig. 2

As a result, the first stereopair gives the image of the cavity in horizontals 11 / Fig. 2b /. When this stereopair observed under the stereoscope 12, a protuberance of the cavity wall and the peculiarities of its topography are seen in relief / Fig. 2b /.

Clinical observation:

A patient O., age - 46 years, has been admitted into the intensive care department with the diagnosis "bilateral fibrous-cavernous tuberculosis with the cavity localization in the upper lobes".

In the process of preparation for treatment caverno-graphy has been done according to the above-mentioned method with the purpose of the specification of tuberculosis cavity inner wall topography, destined to drug treatment. Stereopairs has been done in consecutive order after the administration of 1,2,3,5 ml of a radiopaque substance into the cavity. The result of a survey was the determination of the fact that the inner surface of the front wall has got three hollows of an elliptical shape: a central one - with dimensions of 13 x 9,5 mm; a lateral one - 12 x 5 mm; and a lower one - 16 x 11 mm.

The roentgenotopographic data recieved allowed the surgeon to choose the optimal regimen of the cavity front wall inner surface treatment with antituberculous powdered drug.

A five year clinical experience in phtisiology has shown that the use of roentgen photogrammetry widens considerably the possibilities of radiodiagnosis. The stereoscopic analysis of roentgenograms, accomplished by photogrammetric data, allows the physician to study more minutely the character of pulmonary pathology, to diagnose the disease more safely and to carry out successfully the local treatment of a tuberculous cavity.

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